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Materials Analysis with Highly Charged Ions from EBIT

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Progress in ion source technology, such as the development of the LLNL Electron Beam Ion Trap (EBIT) [1] has made low emittance beams of slow ($v<<v_{Bohr}$) very highly charged ions (HCI) (like Xe52+, Au69+, and in principal up to U92+) available for ion solid interaction studies [2], and the development of materials analysis techniques (e. g. HCI based TOF-SIMS [3]). In the low kinetic energy regime, the advantage of slow, highly charged ions is the extremely high density of electronic excitation energy that can be deposited into a nanometer size volume when a single highly charged ion neutralizes in its interaction with a surface. Several hundreds of keV of neutralization energy are dissipated within tens of femtoseconds. Here, damage of bulk material due to nuclear energy loss processes remains small, since highly charged ions beams can be delivered with kinetic energies of ~ 0.05 - 5 keV / amu. In a complementary scheme, EBITs can be used as injectors into an additional acceleration stage (e. g. a radio frequency quadropol). Taking advantage of the high initial charge states of injected ions, highly charged ion beams with kinetic energies of ~ 10 MeV can now be delivered in a very compact way - as part of "tabletop" experiments. Incentives for this development of compact MeV heavy ion beam systems include their use in Heavy Ion Elastic Recoil Detection Analysis, and other competitive materials analysis techniques.

A progress report will be given on the development of both a low energy, focused highly charged ion beam system, and the EBIT-RFQ compact heavy ion accelerator stage.

Recent results from highly charged ion based materials analysis studies will be reviewed.

References:

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